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ON THE DIURNAL MAGNETIC ACTIVITY IN THE HIGH-LATITUDE
REGIONS AND ON A PROPERTY OF THE SOLAR WIND

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ON THE DIURNAL MAGNETIC ACTIVITY IN THE HIGH-LATITUDE
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by André Lebeau
& Jacky Bitoun

ABSTRACT

The trajectories of the base of geomagnetic field's lines of force passing by the neutral points of the Chapman-Ferraro cavity are calculated. It is shown that the hour of magnetic activity maximum at the Dumont d'Urville station coincides with the moment when the base of the line of force passes nearest the station in the hypothesis whereby the cavity is created by a radial solar wind.

COVER-TO-COVER TRANSLATION

Numerous authors [1 - 4] studied the interaction between the terrestrial dipole and a uniform flow of solar plasma. It is shown that the field is confined inside a cavity around which the flow takes place. The boundary is defined by a rather thin current level. There exist on the surface of that cavity two neutral points at which the lines of force

* Sur l'activité magnétique diurne dans les régions de haute latitude et sur une propriété du vent solaire. (Presented by Jean Coulomb).

meet and then proceed toward the Earth, reaching its surface at two points situated in the vicinity of the geomagnetic poles.

No energy condition of any kind prevents the possibility for a charged particle to reach any depth by following the lines of force passing through the neutral points. Dungey [4] made an attempt to base upon this remark an interpretation of the series of magnetic disturbances observed in the polar regions. This attempt is met with serious difficulties: first, the latitude of the auroral zones does not correspond to the latitude calculated for the base of the line of force, and second, the auroral activity maximum takes place during the night. Per contra, the explanation proposed by Dungey is easily adaptable to the interpretation of the diurnal magnetic activity observed inside the auroral zone.

We propose to confirm this interpretation by computing the trajectory of the base of the line of force which passes by the neutral point and comparing it to what we know of the diurnal variation of the activity.

Spreiter and Briggs [3] have calculated the shape of the cavity for different angles between the dipole axis and the plasma velocity vector using an approximation method, and they determined in particular the position of neutral points.

We have assumed that the presence of the cavity did not impart any deformation on the lines of force sprung from the neutral points.

This approximation is very well verified for the model envisaged by Chapman [6] and in which the plasma is bounded by a plane surface.

It is only moderately verified in the stationary model, but it provides however a first indication, allowing to do away with extremely cumbersome calculations. We applied at the base of the dipole line which passes through the neutral point the correction determined by Hultqvist [7], which takes into account the first five spherical harmonics of the real field. It is legitimate to admit that at the neutral point level the dipole field line and that of the real undistorted field that would pass through the same point of the equatorial plane, still are confused or nearly so.

We have conducted the computations for the values of the characteristic radius r_0 of the cavity equal to 8.5, 12.5 and 14.5 earth radii. The trajectory is only little affected by the variation of r_0 . Indeed, the latitude Φ of the base of the line of force is connected with r_0 by a relation of the form: $\cos \Phi \propto r_0^{-\frac{1}{2}}$.

We have determined the trajectory by 48 points corresponding to hours and half-hours UT for the equinoxes, solstices and the equidistant days of an equinox or a solstice. The trajectories obtained are plotted in Fig. 1.

We have compared the level of diurnal activity at the Dumont d'Urville station with the distance from the station to the base of the line of force by utilizing the Lebeau and Schlich curve [8].

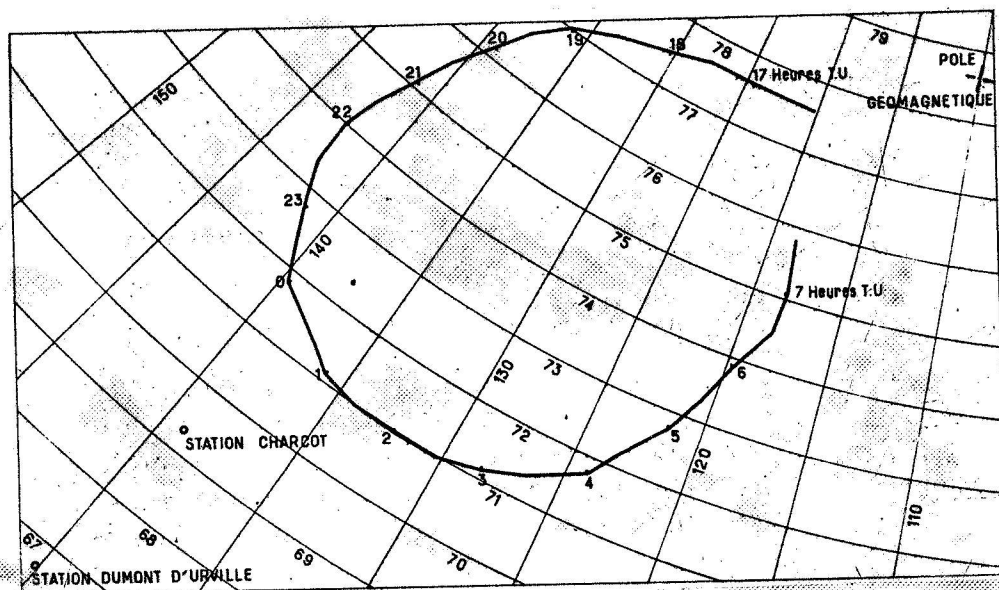


Fig. 1

TRAJECTORY OF THE BASE OF THE LINE OF FORCE
PASSING THROUGH THE NEUTRAL POINT
($r_0 = 12.5$ earth radii, 305th day of the year)

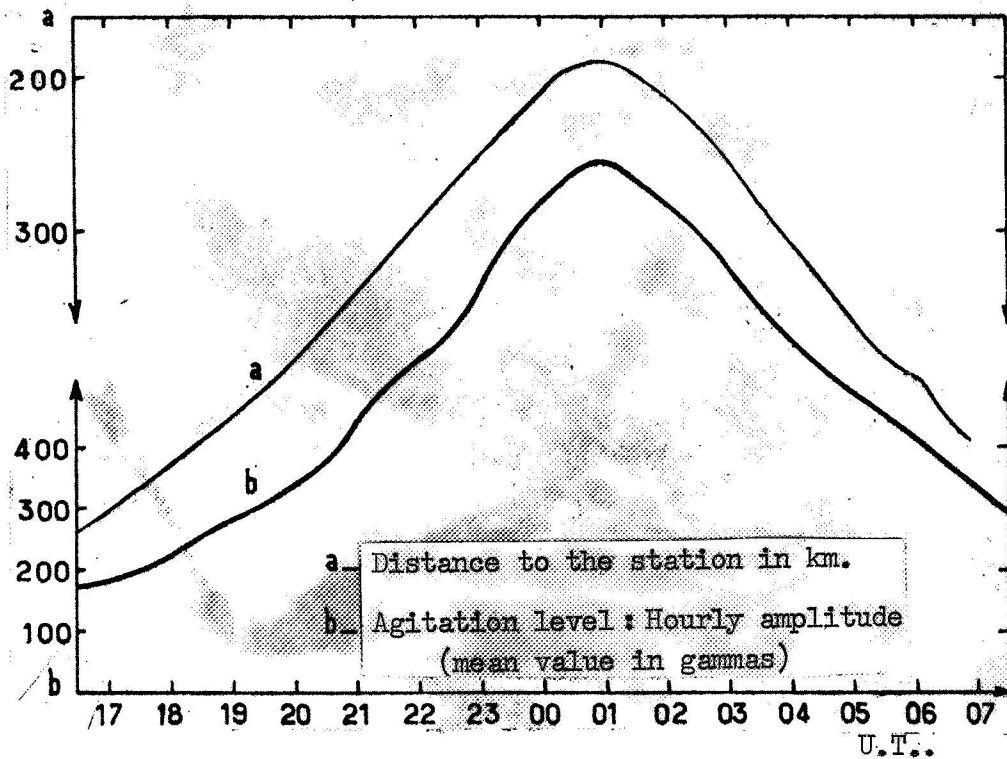


Fig. 2

Figure 2 shows the result thus obtained. The hour of maximum activity coincides exactly with the hour corresponding to the minimum distance. Elsewhere, in the vicinity of the extremum, the activity measured by the average of hourly amplitudes in gammas, is in the first approximation inversely proportional to the distance to the base of the line.

This result confirms the existence of a relation between the diurnal activity and the presence of neutral points on the cavity. It shows, on the other hand, that as an average, the solar wind is radial at the terrestrial orbit level.

The calculations were effected with the aid of an I.B.M.1620 computer.

***** THE END *****

(Ionospheric Research Group)

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